STEM IN THE LAB

innovate. explore. discover.

Idaho National Laboratory

OUR MISSION

INL's K-12 STEM Program works to inspire Idaho's future STEM workforce, impact students, teachers and families by integrating best practices in STEM education, and empower employees to become STEM mentors to transform K-12 STEM into a driver for innovation.

FERMENTATION IN A BAG OVERVIEW

A unique quality of biomass is its ability to store energy from the sun in a chemical form. Help your students understand one way to harvest energy from biomass – by fermenting a plant-based sugar! See this recommended procedure from the Great Lakes Bioenergy Research Center!

VOCABULARY

BIOMASS: *An energy resource derived from organic matter used to produce energy from chemical processes, including wood, agricultural waste, and other living-cell material.*

BIOMASS: *energy produced from biomass and includes biofuels, bio-based products, and biopower.*

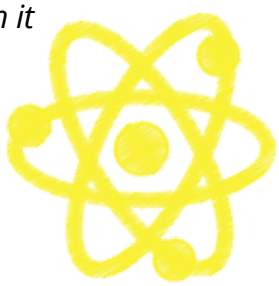
BIOENERGY FEEDSTOCKS: *Any material used directly as a fuel or converted to another form of fuel or energy product that has undergone one or more preprocessing operations to meet the required quality characteristics for feeding into a biorefinery.*

CELLULOSIC BIOFUELS: *Biofuels produced from cellulosic non-food biomass resources, including crop residues (e.g., corn cobs, stalks), forestry residues (e.g., forest thinning, wood byproducts), energy crops (e.g., switchgrass, miscanthus), sorted municipal wastes, and algae.*

NEXT-GENERATION BIOENERGY FEEDSTOCKS: *Non-food and waste biomass materials that are used to produce advanced bioenergy and include: Agricultural and forestry residues, Energy crops, Algae, Sewage, Municipal solid wastes, gaseous wastes, other organic, non-food substances.*

CELLULAR RESPIRATION: *Cellular Respiration a metabolic pathway that breaks down glucose and produces ATP, the energy source for a cell.*

PHOTOSYNTHESIS: *Photosynthesis the process used by plants, algae and certain bacteria to harness energy from sunlight and turn it into chemical energy.*



FERMENTATION: *Fermentation the chemical breakdown of a substance by bacteria, yeasts, or other microorganisms, typically involving fizzing and the giving off of heat.*

RESEARCH AND DESIGN PROCESS

PROCEDURES

1. *In a snack-size resalable zipper bag, combine feedstock (1 teaspoon of sugar) and a living enzyme (1 teaspoon of yeast).*
2. *Add 50 mL (1/4 cup) of warm tap water (approximately 40° C) and seal bag closed, removing as much air as possible.*
3. *Mix gently. Lay bag on a flat surface and watch for results – fastest results should be achieved in 15 minutes.***

Optional: Measure and compare ethanol and/or CO2 production using ethanol probes, breathalyzers, rulers, etc. Discuss and interpret results.

***Warning: As the yeast produce carbon dioxide, the bag will expand – it may even pop! Be sure to monitor the bag and release the gas if it becomes too inflated.*

EXTENSIONS

- *Students can choose a variable to test such as variations on temperature, pH, or salinity.*
- *For older students this can lead into a discussion on how rates of reaction are determined.*
- *Have a sample of sand and compare it to the yeast, lead a discussion on living vs. nonliving things. How would students test this?*

CONNECTIONS

BIOLOGY

- *Discuss how the flow of matter moves through an ecosystem, where does the energy come from? How is it captured?*
- *Compare fermentation to cellular respiration and fermentation to photosynthesis. Ask students the connections or similarities.*

CHEMISTRY

- *Discuss chemical vs. physical change, how can students tell what type of change it is?*
- *What are the signs that a chemical reaction has occurred?*

RESOURCES

https://www.glbrc.org/outreach/educational-materials/fermentation-bag
https://www.nextgenscience.org/sites/default/files/AllDCI.pdf

STANDARDS

- *NGSS Science and Engineering Practices: Planning and Carrying Out Investigations, Constructing Explanations and Designing Solutions*
- *PS3.A: Definitions of Energy*
- *PS3.B: Conservation of Energy and Energy Transfer*
- *ETS1.A: Defining and Delimiting an Engineering Problem*
- *NGSS Crosscutting Concepts: Systems and System Models, Energy and Matter*